An Investigation of Low Ozone Anomalies in the Winter Middle Stratosphere Using a Lagrangian Photochemical Model

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On several distinct occasions, tile Microwave Limb Sounder (MLS) instrument aboard the Upper Atmosphere Research Satellite (UARS) has observed pockets of stratospheric air outside the winter polar vortex which have ozone abundances comparable to those within the vortex (~5 ppmv). Trajectory calculations by Manney *et al.* (19'34) indicate that air in the low ozone anomalies originated in the tropical middle stratosphere, where the ozone abundances are considerably higher (~ 8-9 ppmv). The trajectory model, along with passive tracer data (UARS measurements **of** N_2O and CH_4) rules out **a** purely dynamical **explanation for the** low ozone bubbles.

Using the Caltech/JPL photochemical model, we have investigated an example of this occurrence which took place from late February to early March 1993. The model has been adapted to operate in a Lagrangian fashion, where the chemistry of an air parcel with a specified trajectory is simulated, accounting for changes in temperature, radiation field, and other relevant physical parameters as warranted by the travel path.

We have compared the observed ozone decrease with model talc.ulatio]ls for the net change in ozone, integrated over the three week period of interest. Since the loss rate is dependent upon the ozone abundance, the concentration of ozone in the model is constrained to vary with time according to the UARS observations. Observations of H_2O, N_2O, HNO_3, CH_4, and $ClONO_2$ at the parcel location made by MLS and the Cryogenic Limb Array Etalon Spectrometer (CLAES) are similarly assimilated into the model.

The change in ozone predicted by the model agrees well with the observed decrease. Near the center of the low ozone pocket, the measured decrease in ozone over the three week period is 3.4 ppmv, compared to 3.6 ppmv predicted by the model. Near the edge of the anomaly, the model decrease of 2.7 ppmv compares well with the observed drop of 2.4 ppmv. Most of the ozone decrease occurs as the parcel moves northward, with the chemical loss rate exceeding the decreasing rate of oxygen photolysis at increasingly higher latitudes as the parcel approaches a new photochemical equilibrium.

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